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COMPARISON OF EFFECTS BETWEEN LOCALLY MADE AND COMMERCIAL DIETS ON THE GROWTH AND PRODUCTION OF FRESHWATER PRAWN *Macrobrachium rosenbergii* IN RAIN-FED FALLOW RICE FIELDS

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Abstract

One of the main constraints for the emerging freshwater prawn farming in Bangladesh is scarcity of feed and its high price. To overcome this problem low cost feed with locally available ingredients needs to be developed. An on-farm experiment was carried out to determine the effects of two locally made and one commercial diet on the growth and production of freshwater prawn *Macrobrachium rosenbergii* in rain-fed fallow rice fields at Mymensingh, Bangladesh. Feed were tested with four replicates: Locally made pelleted feed containing 30% protein (treatment-Local 30) and 28% protein (treatment-Local 28) and commercial pellet feed containing 28% protein (treatment-Commercial 28). During research period the costs of feed were BDT 22 kg^{-1}, BDT 21 kg^{-1} and BDT 25 kg^{-1}, respectively for Local 30, Local 28 and Commercial 28. Each treatment plot was stocked with 20,000 ha^{-1} freshwater prawn, 20,000 ha^{-1} mola and 2,000 ha^{-1} catla. Feed were applied twice daily at the rate of 3-8% (initially 8% and gradually reduced up to 3%) of body weight. Water quality parameters were monitored monthly and there was no significant difference among the treatments. All water quality parameters were found to be within the suitable range for freshwater prawn culture. Abundance of plankton communities did not show any significant differences among the treatments. Feed Conversion Ratio (FCR) in treatments Local 30, Local 28 and Commercial 28 were 2.1, 2.4 and 2.6, respectively. There was no significant difference in production and survival of fish and prawn among the treatments. Comparatively better benefit-cost ratio of 1:1.8 was estimated in the Local 30, but there were no significant differences among the treatments. It can be concluded that locally made feed can be used economically for prawn culture. Another advantage of this feed is that farmer can easily prepare this feed using locally available ingredients with a low-cost hand pellet machine.

Key words: Freshwater prawn, rice-fields, locally made feed, commercial feed

Introduction

Bangladesh has emerged as one of the world's leading fish producing countries with a total production of 3.26 million metric tons of which aquaculture contribution is 1.73 million metric tons (53% of the total production). The average growth rate of aquaculture production in Bangladesh has been approximately 19% per annum since last ten years, comparable to China and India (DoF, 2013). The fisheries sub-sector in Bangladesh plays an important role in alleviating protein deficiency, generating employment, reducing poverty and earning foreign exchange. This sub-sector contributes 4.39% to GDP representing 22.76% of the agriculture sector (DoF, 2013). About USD 590 million was earned by exporting 92479 metric tons of fish and fisheries products in 2011-2012 contributing 2.46% of the country's total export earning (DoF, 2013). About 11% of the total population of Bangladesh engaged directly or indirectly in this sector.

The country is blessed with vast inland waterbodies comprising of 2,832,792 ha of floodplains, 853,863 ha of rivers and estuaries, 114,161 ha of beels (natural depressions), 68,800 ha man-made reservoir (Lake Kaptai), 305,025 ha of inland pond and ditches, 5,488 ha of oxbow lakes and 217,877 ha of shrimp farms (DoF, 2009). The above mentioned 2.83 million ha floodplains are used to grow mainly one crop of boro rice from January to May and remaining part of the year, the lands lie fallow and flooded under monsoon water. The carrying capacities of these

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lands and waters are not yet fully utilized, but there exists tremendous potential for increasing fish/prawn production by integrating aquaculture in these inundated rice fields.

The freshwater prawn (*Macrobrachium rosenbergii*) is considered as a popular and prime candidate species for freshwater aquaculture world-wide for its distinctive taste, rapid growth rate, large size, disease resistance compared to its marine counterpart *Penaeus monodon* and having high demand in both domestic and international markets. The popularity of this freshwater species has gained importance day by day and developing its culture technology (New, 2002). Frozen shrimp (mainly *Penaeus monodon* and *Macrobrachium rosenbergii*) contributed 77.4% of the total export value among fish and fishery products of which freshwater prawn contributes less than a quarter to the total export by quantity and value (DoF, 2013). However, although tiger shrimp (*Penaeus monodon*) contributes the majority of the export value, further expansion of culture area and increased culture intensity are not possible due to repeated disease outbreaks and associated environmental degradation in coastal region (Johnson and Bueno, 2000). These social and environmental conflicts associated with marine shrimp farming are making freshwater prawn farming more attractive (New, 2000). At present only about 50,000 ha of water areas in Bangladesh are used for freshwater prawn culture (DoF, 2007) and it can be cultured in the vast areas of rice fields and ponds throughout the country, if the supply of hatchery-produced seeds is ensured.

One of the main constraints for the emerging freshwater prawn farming in Bangladesh is scarcity of feed and its high price. Most of the feeds available in the market are not good in quality for prawn farming. Moreover, farmers of rural area did not get feed in proper time. To overcome this problem low cost feed with locally available ingredients needs to be developed. Therefore, an on-farm experiment was carried out to determine the effects of two locally made and one commercial diet on the growth and production of freshwater prawn *Macrobrachium rosenbergii* in rain-fed fallow rice fields at Mymensingh, Bangladesh. The advantage of locally made feed is that the farmers can easily prepare these feed using locally available ingredients with a low-cost hand pellet machine.

Objectives

1. To evaluate the effects of different diets on the growth and production of freshwater prawn in alternate method of rice-fish culture systems;
2. To prepare a low-cost freshwater prawn diet using locally available ingredients; and
3. To observe the variation of water quality parameters and plankton abundance in different diets.

Materials and Methods

The experiment was carried out in 12 different size farmers' rice plots ranging from 0.06 hectare to 0.10 hectare in Gouripur upazila of Mymensingh district, Bangladesh from 10 August to 10 November 2008. Alternate method of rice-fish culture systems was followed in this experiment.

Pre-stocking preparations

After harvesting of Boro rice (January to May), plots were kept fallow for few days to rotten the rest part of rice straw in the field. Construction of embankments (1.5 m height and 1.5 m width) were done by the farmers for dyke cropping prior to initiate the research programme. Ditches (1 m depth and 10-15% of the total area) were constructed before supplying water into the plots. Then after raising the water level up to 2-3 feet liming was done at the rate of 125 kg ha^{-1}. After 7 days of liming fertilization was carried out with urea, TSP and cow manure at the rate of 25 kg ha^{-1}, 25 kg ha^{-1} and 500 kg ha^{-1}, respectively.

Experimental design

Three types of feed were tested with four replicates: Locally made pellet feed containing 30% protein (treatment-Local 30) and 28% protein (treatment- Local 28) and commercial pellet feed containing 28% protein (treatment-Commercial 28). Ingredients used in the diets are given Table1. Prawn and fish were stocked in the experimental plots after one month of fertilization. It was late due to scarcity of prawn juveniles when needed. Freshwater prawn, catla and mola were stocked at a density of 20,000 ha^{-1}, 2,000 ha^{-1} and 20,000 ha^{-1}, respectively. Stocking density was same in all the treatments.

Table 1. Ingredients used in different diets

Diets	Ingredients (%)					
	Rice bran	**Mustard oil cake**	**Fish meal**	**Wheat flour**	**Maize flour**	**Vitamin premix***
Local 30	29	10	32	12	17	1
Local 28	29	20	27	10	14	1
Commercial 28	Unknown					

**Vitamin premix is mixed as extra along with the main ingredients of the feed.*

Stocking and management of prawn and fish

The juveniles of prawn, catla and mola were collected from a local fry trader. All fry were transported from nursery to research site in plastic containers with aeration. The containers were kept in the experimental plots for about 30 minutes to let the juveniles adjust with new environment and then released gradually in the experimental plots.

Two locally made and one commercial pellet feed of prawn were supplied to the experimental plots separately in three treatments at 3-8% (initially 8% and gradually decreased up to 3%) body weight of prawn. One third of the feed is supplied at early morning and two third of the feed in the evening. Catla were fed with mustard oil cake and rice bran (1:3 ratios) at 3% of body weight and supplied in the morning between 09.00-10.00 AM. To maintain good production of natural feed plots were fertilized with urea, TSP and cow manure every 10 days interval at the rate of 12.5 kg ha^{-1}, 12.5 kg ha^{-1} and 250 kg ha^{-1}, respectively. Liming was done once in a month at the rate of 25 kg ha^{-1}.

Sampling of prawn and fish

Fish and prawn were sampled by using a seine net once in a month to assess their growth and health condition. The length and weight of 20 individuals of each species were recorded for growth assessment.

Water quality monitoring

Monitoring of water quality parameters, water temperature, transparency, pH, DO, NH_3, NO_3-N, NO_2-N, PO_4-P, total alkalinity and chlorophyll-a was carried out at 30 days intervals starting from 08 August 2007 before two days of stocking the prawn and fish fry. Temperature and dissolved O_2 were measured by a digital DO meter (YSI model 58). Transparency was measured by using a secchi disc and pH with a pH meter (Hach, model 51910). Total alkalinity was determined titrimatrically. NH_3-N, PO_4-P, NO_3-N and NO_2-N were determined by spectrophotometer (DR/2010 model). Chlorophyll-a was measured by spectrophotometer (Milton Roy Spectronic 1001 Plus). Temperature (^{0}C), pH, transparency (cm) and dissolved oxygen (mg l^{-1}) were measured directly in the rice plots between 0900-1100 hr and other parameters were measured at 30 days intervals at the Water Quality and Pond Dynamics Laboratory, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Standard procedures and methods were followed (Stirling, 1985; American Public Health Association, 1992) for the analyses of the water samples.

Plankton enumeration

Qualitative and quantitative measurements of plankton were done at 30 days intervals. First sample was taken before two days of stocking of prawn and fish fry. Ten liters of water samples were collected from five different places of each plot, concentrated to 50 ml by using a plankton net (mesh size 20 μm) and preserved with 10% formalin for plankton counting (Beveridge, 1985). The preserved plankton samples were studied by using a Sedgewick-Rafter counting cell (S-R cell), under a binocular microscope (Olympus, M-4000D) following Stirling (1985). Identification of plankton to genus level was carried out using the keys from Prescott (1962) and Bellinger (1992). The quantitative estimation was made following Stirling (1985).

Harvesting of fish

Fish and prawn were harvested by repeated netting and dewatering of the rice plots. During harvesting the bulk weight of prawn, mola and catla were measured separately and recorded. After two months of stocking, partial harvesting of mola was done frequently (at least twice a month), and recorded by the farmers. They used Push net/Lift net/Cast net for harvesting of mola and carefully released back the offspring into the water. There was no involvement of extra expenditure to catch mola as the farmers or their family members both woman and children can operate these gears. Specific growth rate (SGR) was calculated as follows: SGR (% bw d^{-1}) = (ln(final weight)-ln(initial weight))/culture period in days × 100.

Cost and return analysis

Benefit-cost of different treatments were calculated on the basis of the expenditure incurred and the total return from the selling price of mola, prawn and calta. The cost of fertilizer, fish seed price (including transport) and price of feed was estimated. At the end of the experiment, fish and prawn were sold in a local market. The analysis was based on market prices in Bangladesh for fish and all other items expressed in Taka. (US $1= Tk. 70.00 during project period). However, the net benefit and benefit-cost ratio (BCR) were calculated by using the following formula:

Net benefit = Total revenue (Tk.) – Total cost (Tk.)
BCR= Total revenue/Total cost

Statistical analysis

Water quality parameters and plankton data were compared by two-way repeated measures ANOVA with treatment as main factor and sampling date as repeated measures factor (Gomez and Gomez, 1984). The fish yield parameters were compared using one-way ANOVA. If main effects were significantly different, differences among the treatments were tested with Tukey's multi-comparison test of means. The analyses were run at 5% significance level using SPSS statistical package.

Results

Growth, survival and production of prawn and fish

The results of growth parameters of prawn and fishes are shown in Table 2. About 60% prawn did not reach at marketable size (above 35g), because the culture tenure was only three months. Due to lack of prawn juvenile we started the experiment late and due to scarcity of water we had to stop the research by three months. There were no significant differences ($P<0.05$) of stocking and harvesting weight of prawn among treatments. Survival and SGR of prawn did not show any significant differences among the treatments. Gross production of prawn was found to range from 432-484 kg ha^{-1} without showing any significant differences among treatments. Mean stocking weight of mola did not show any significant differences ($P<0.05$) among treatments. Mola bred during the experimental period, so the harvesting number was much higher than stocking. After one week of first breeding, farmers' started catching of mola once in a week for their family consumption. Gross production of mola was found to range from 167-184 kg ha^{-1} and there was no significant differences among treatments.

Table 2. Comparisons of means (±SE) of yield parameters of freshwater prawn, catla and mola in different treatments during a three months culture period

Species/Parameters	Treatments		
	Local 30	Local 28	Commercial 28
Freshwater prawn			
Individual stocking weight (g)	2.35 ± 0.10	2.40 ± 0.08	2.51 ± 0.07
Individual harvesting weight (g)	34.69 ± 0.96	30.48 ± 3.18	33.08 ± 0.43
Survival	70.74 ± 1.93	72.73 ± 2.38	66.19 ± 2.25
SGR (%bw day^{-1})	2.93 ± 0.03	2.75 ± 0.12	2.81 ± 0.08
Gross yield (kg ha^{-1})	484.37 ± 13.18	441.43 ± 57.76	432.76 ± 16.78
Net yield (kg ha^{-1})	437.91 ± 12.33	394.03 ± 57.95	383.26 ± 19.65
Catla			
Individual stocking weight (g)	23.87 ± 0.37	23.88 ± 0.50	24.94 ± 0.16
Individual harvesting weight (g)	250.81 ± 10.97	239.31 ± 8.81	235.83 ± 5.29
Survival	92.50 ± 1.75	94.60 ± 0.80	93.47 ± 2.51
SGR (%bw day^{-1})	2.55 ± 0.03	2.50 ± 0.05	2.44 ± 0.03
Gross yield (kg ha^{-1})	457.45 ± 12.97	447.49 ± 18.31	435.74 ± 16.54
Net yield (kg ha^{-1})	410.28 ± 12.32	400.31 ± 18.21	386.46 ± 16.81
Mola			
Individual stocking weight (g)	1.16 ± 0.03	1.19 ± 0.08	1.16 ± 0.06
Gross yield (kg ha^{-1})	184.22 ± 23.08	167.06 ± 15.03	176.21 ± 36.72
Net yield (kg ha^{-1})	161.27 ± 23.61	143.54 ± 13.86	153.36 ± 37.25

There was no significant differences ($P<0.05$) of stocking and harvesting weight of catla among the treatments. Harvesting weight of catla varied between 236-251g and survival varied between 92-95% among the treatments. There were no significant differences of harvesting weight and survival among the treatments. SGR of catla also did

not show any significant differences among the treatments. Gross production of catla was found to range from 436-458 kg ha^{-1} and there were no significant differences among the treatments. Combined production of fish and prawn in different treatments were 1126 kg ha^{-1}, 1056 kg ha^{-1} and 1045 kg ha^{-1}, respectively in treatment Local 30, Local 28 and Commercial 28 and there were no significant differences among the treatments. FCR in treatments Local 30, Local 28 and Commercial 28 were calculated 2.1, 2.4 and 2.6, respectively. Comparatively better FCR found in treatment Local 30.

Benefit-cost ratio (BCR)

At the end of the research economic feasibility of different treatments were analyzed on the basis of the expenditure incurred and total return from sale price of fish and prawn in the local market. The benefit-cost ratio was calculated 1.80:1, 1.69:1 and 1.58:1, respectively in treatment Local 30, Local 28 and Commercial 28 and there were no significant differences among the treatments. Results of cost-benefit ratio are shown in Table 3.

Table 3. Comparisons of economics among different treatments based on 1 ha farm area and 3 months culture period. Currencies are given in Bangladesh Taka (1 USD = 70 BDT)

Items	Treatments		
	Local 30	**Local 28**	**Commercial 28**
Financial inputs			
Lime, urea and TSP	5,820	5,820	5,820
Feed	20,240	19,857	24,895
Mola, catla and prawn seeds	104,000	104,000	104,000
Total investment	**130,060**	**127,209**	**134,715**
Financial returns			
Prawn sale	169,540	154,350	151,480
Mola sale	27,630	25,050	26,430
Catla sale	36,600	35,800	34856
Total returns	**233,770**	**215,200**	**212,766**
Net benefit	**103,710**	**87,991**	**78,051**
Benefit-cost Ratio (BCR)	**1.80**	**1.69**	**1.58**

Water quality parameters

Water quality parameters were monitored monthly and the results are summarized in Table 4. There were no significant differences in water quality parameters among different treatments except pH. The values of pH fluctuated between 7.0 to 8.6 which are suitable for fish/prawn polyculture. According to Boyd (1992) all the water quality parameters found suitable range for fish-prawn polyculture.

Table 4. Mean values (± SE) of water quality parameters

Parameters	Treatments		
	Local 30	**Local 28**	**Commercial 28**
Temperature (^{0}C)	29.86 ± 0.96	29.96 ± 1.03	29.80 ± 1.02
Transparency (cm)	20.19 ± 0.96	20.81 ± 0.53	20.38 ± 0.39
DO (mg l^{-1})	5.87 ± 0.11	5.97 ± 0.07	5.91 ± 0.05
pH	7.70	7.58	7.64
Chlorophyll-a (μg l^{-1})	100.09 ± 11.05	113.81 ± 8.69	80.28 ± 14.36
Alkalinity (mg l^{-1})	99.50 ± 4.25	87.75 ± 7.26	90.38 ± 4.68
NH_3 (mg l^{-1})	0.20 ± 0.01	0.22 ± 0.03	0.19 ± 0.02
PO_4(mg l^{-1})	1.21 ± 0.23	1.41 ± 0.20	1.00 ± 0.16
NO_3 (mg l^{-1})	0.049 ± 0.005	0.043 ± 0.006	0.049 ± 0.008
NO_2(mg l^{-1})	0.004 ± 0.001	0.003 ± 0.001	0.004 ± 0.001

Plankton abundance

Mean (±SE) abundance of phytoplankton and zooplankton are shown in Table 5. Four groups of phytoplankton includes Bacillariophyceae (11, genera), Chlorophyceae (36, genera), Cyanophyceae (10, genera) and Euglenophyceae (4, genera) and four groups of Zooplankton includes Rotifera (7, genera), Cladocera (5, genera), Copepoda (3, genera) and Crustacean nauplius were identified in the present study. Among all the groups of phytoplankton and zooplankton only Chlorophyceae showed significant differences in different treatments. Mean abundance of total phytoplankton and total plankton was significantly higher in treatment Local-30 than treatment commercial-28, but did not differ with treatment Local-28. Among the phytoplankton Chlorella, Colestrum, Ulitrix,

Gomphospharia, Pediastrum, Oscillatoria and Euglena were dominant. In case of zooplankton, Keratella, Brachionus, Diaphanosoma and Moina were dominant.

Table 5. Group-wise mean abundance of plankton numbers (x 10^3 cells l^{-1}) in different treatments. Mean values with different superscripts indicate significant difference (P<0.05) based on Duncan test

Plankton group	Treatments		
	Local 30	Local 28	Commercial 28
Bacillariophyceae	3.19 ± 0.51	3.91 ± 0.64	2.75 ± 0.47
Chlorophyceae	37.13 ± 6.26[a]	24.03 ± 3.41[b]	23.03 ± 2.39[b]
Cyanophyceae	11.25 ± 5.06	8.09 ± 1.36	6.06 ± 1.50
Euglenophyceae	3.09 ± 0.86	3.47 ± 0.78	2.34 ± 0.78
Total Phytoplankton	54.66 ± 10.01[a]	39.50 ± 3.43[ab]	34.19 ± 2.80[b]
Rotifera	2.91 ± 0.64	3.17 ± 0.45	3.53 ± 0.63
Cladocera	2.78 ± 0.48	2.19 ± 0.36	1.72 ± 0.37
Copepoda	1.00 ± 0.28	1.13 ± 0.16	0.84 ± 0.18
Crustacea (Nauplius)	0.94 ± 0.31	0.69 ± 0.24	0.59 ± 0.17
Total Zooplanklton	7.63 ± 0.93	7.16 ± 0.52	6.69 ± 0.89
Total Plankton	62.28 ± 10.26[a]	46.66 ± 3.34[ab]	40.88 ± 3.01[b]

Discussion

Freshwater prawn (*Macrobrachium rosenbergii*) has been introduced to aquaculture in the coastal areas and few of other areas depending on naturally collected seed and snail meat as feed. In Bangladesh, its culture started as a commercial venture in the later part of 1980's (Karim, 1989). The prawn farming area is expanding very fast in coastal region, especially in South-western region of Bangladesh; the expansion rate over last 3 years is about 10% per year. At present the area of prawn aquaculture in different categories of land and waterbodies is about 50,000 ha (DoF, 2007). Though there is a great potential for freshwater prawn culture all over Bangladesh, but it is hampering due to lack of prawn feed. In this study we tried to find out that feed made with locally available ingredients may have significant impact on the production of freshwater prawn like commercial feed.

In the present study growth, survival and production of freshwater prawn did not differ significantly among the treatments and water quality parameters also did not differ significantly among the treatments which revealed that the efficiency of local feed is comparable to the commercial feed. Except chlorophyceae plankton abundance did not show any significant differences among the treatments which also support these findings. Freshwater prawn production observed satisfactory in context of the findings of the other scientists in this region. Sadek & Moreae (1998), Asaduzzaman *et al.* (2006), Kunda *et al.* (2008) and Wahab *et al.* (2008) found freshwater prawn production 254 kg ha^{-1}, 390 kg ha^{-1}, 294-596 kg ha^{-1} and 222-388 kg ha^{-1}, respectively from polyculture with other fishes in rice-fish culture system, which are similar to the present production. Mires (1987) observed 1045 kg ha^{-1} from 6 months culture period and Kunda *et al.* (2009) obtained 596-730 kg ha^{-1} production from 4 months culture period, both are higher than that of present production. Haroon and Alam (1992) observed a prawn production of 220 kg ha^{-1} in rice fields from a 160 days culture period and Lan *et al.* (2006) reported that net production of freshwater prawn ranged from 194-373 kg ha^{-1}, respectively during a 210 days culture period in rotational rice-prawn systems, both of which are lower than the production observed in the present study. Production of catla and mola also did not differ among the treatments and it was observed satisfactory in context of the findings of the other scientists in this region. Production of mola comparable to the production obtained by Wahab *et al.* (2008) and Kunda *et al.* (2009) in their study from rice-fish/prawn culture system.

In case of benefit-cost ratio, we did not found any significant differences among the treatments. Actually, except feed cost the total expenditure was same in all the treatment. In case of feed the total amount of feed used in all the treatment was lesser amount as it was only a three months trial. Therefore, though the locally made feed cost is lower than the commercial feed, yet it could not affect the benefit-cost ratio. During the time of this experiment the rate of locally made feed was Taka 5/kg lower than the commercial feed. On the other hand, calculated FCR found lower in locally made feed than the commercial one. The ingredients which are used for local-28 and local-30 feed are available throughout the country and the procedure of making feed also very easy. So farmers can use these feed for commercial freshwater prawn culture system.

Production of freshwater prawn and fish did not show any significant differences among the treatments, but locally made feed may be recommended for freshwater prawn culture due to following reasons:

- Locally made pellet feed is comparable to the commercial diet in terms of production.
- Locally made diet is cheaper than the commercial one.
- Locally made pellet is more sustainable as the ingredients are locally available.
- Farmers' can easily prepare this feed using hand pellet machine as and when needed.

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